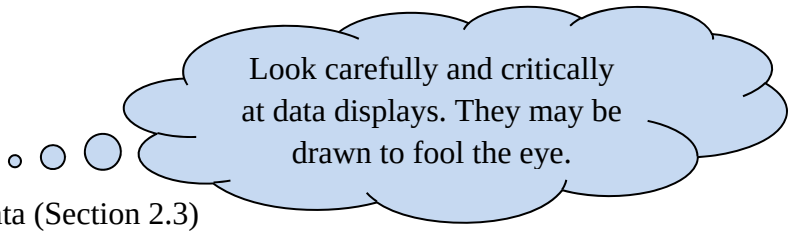
General Education Statistics
Class Notes
Graphical Misrepresentations of Data (Section 2.3)




"There are three kinds of lies: lies, damned lies, and statistics." (British Prime Minister Benjamin Disraeli, 1804-1881) This saying was popularized by Mark Twain.

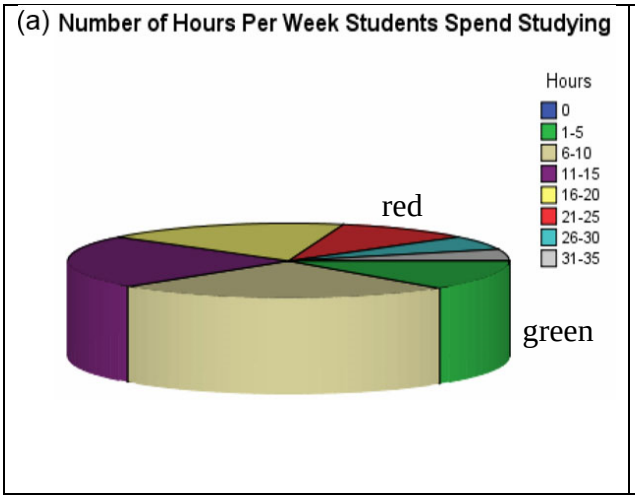
As producers of data displays and statistics, we try hard to provide accurate depictions. As consumers, we must be on the lookout for misleading (intentional or not) displays. We will look at a few ways this can be done.

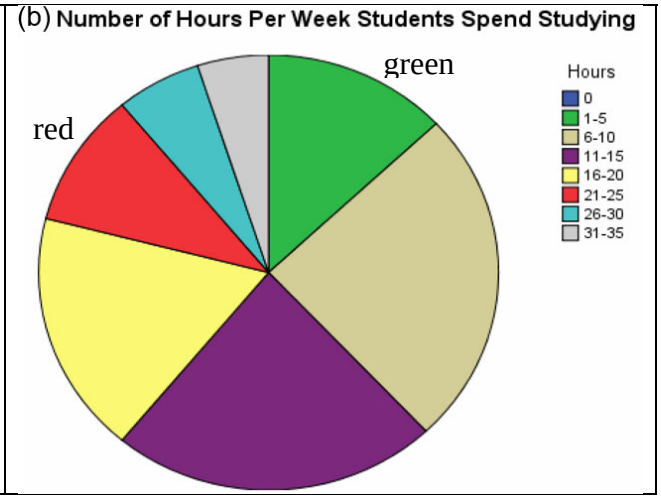
The book labels it **misleading** if it is unintentional. If it is done on purpose, the book calls that **deceptive**.

**Three-dimensional Charts and Graphs:**

Consider the two pie charts that purport to tell us the same story.

The National Survey of Student Engagement is a survey that (among other things) asked first year students at liberal arts colleges how much time they spend preparing for class each week. The results from the 2007 survey are summarized in these dramatically different pie charts.




We, in trying to make our graphics more dynamic and interesting, do some pretty irresponsible things. Three-dimensional graphs are often hard to read properly. Which graph shows the true relationship between the "1-5 hours" (green) group and the "21-25 hours" (red) group more accurately?

You should never use three-dimensional graphics. Labeling each sector with its percentage would help. Yet it is still hard for our minds to disavow what our eyes incorrectly see.

**Adjusting the Scale of Graphs:**

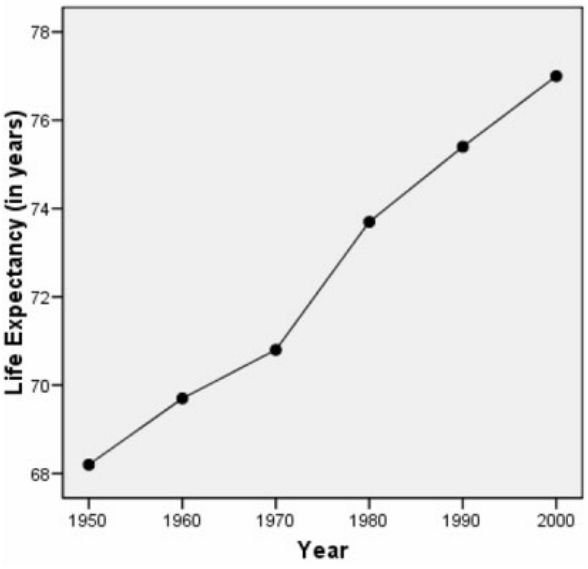
expl 1: Consider the data for the life expectancies (in years) of residents of the United States through the last half-century. (Source: National Center for Health Statistics)

| Year | Life Expectancy (in years) |
|---|---|
| 1950 | 68.2 |
| 1960 | 69.7 |
| 1970 | 70.8 |
| 1980 | 73.7 |
| 1990 | 75.4 |
| 2000 | 77.0 |

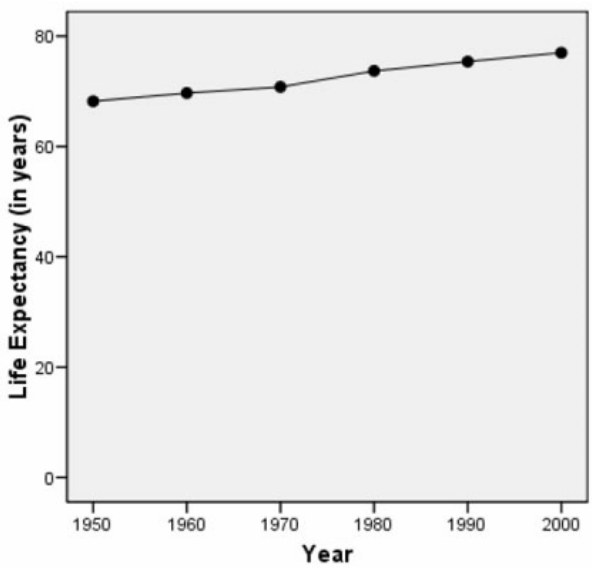
Looking at the table, how would you describe the data?

The table lists out the data in a straightforward way. How could a graph possibly change that?

(a)




(b)

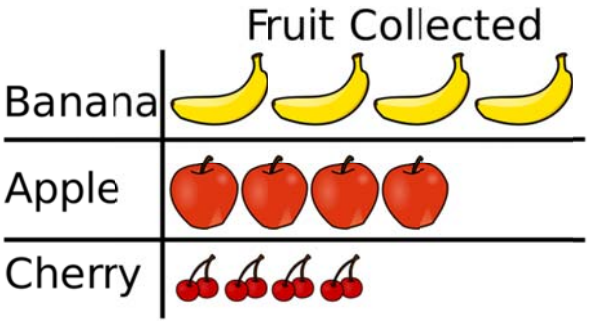



Comment on how these graphs make you feel about the trend in life expectancy in the US. What makes the difference? Which do you interpret as more accurate? Why?

**Pictographs:**

Pictographs use pictures to make the graphics look fancier. Consider these examples.

expl 2: Here we see a pictograph. At first glance, what fruit was collected the most? Looking closer, do you still think your answer is correct? How could this graph be fixed?




(Source: https://upload.wikimedia.org/wikipedia/commons/thumb/a/aa/Pictograph_not_aligned_and_different_size.svg/2000px-Pictograph_not_aligned_and_different_size.svg.png)

expl 3: Here we see another pictograph. The numbers show that the 1980 purchasing power of the Canadian dollar (in terms of the American dollar) is twice that for the year 1995. However, the area of the coins (which is what our minds really compare) tell a different story. Why is that?


**Purchasing power:** the value of money in terms of how much it can buy

(Source: https://www.statcan.gc.ca/edu/power-pouvoir/ch9/img/5214825_02-eng.jpg)

**Not always bad:**
Pictographs, if carefully constructed, can make good displays.

This pictograph shows the same information. However, you will notice that the relative sizes are *not* skewed. Only one dimension was reduced to show the decrease in purchasing power.


**Guidelines for Constructing Good Graphics:**

- Title and label the graphic axes clearly, providing explanations, if needed. Include units of measurement and a data source when appropriate.
- Avoid distortion. Never lie about the data.
- Minimize the amount of white space in the graph. Use the available space to let the data stand out. If scales are truncated, be sure to clearly indicate this to the reader.
- Avoid clutter, such as excessive gridlines and unnecessary backgrounds or pictures. Don't distract the reader.
- Avoid three dimensions. Three-dimensional charts may look nice, but they distract the reader and often lead to misinterpretation of the graphic.
- Do not use more than one design in the same graphic. Sometimes graphs use a different design in one portion of the graph to draw attention to that area. Don't try to force the reader to any specific part of the graph. Let the data speak for themselves.
- Avoid relative graphs that are devoid of data or scales.

**Worksheets:**
**Data Displays 2:** This worksheet reviews stem-and-leaf plots and pie charts. We will also see how the scale of a line graph affects its meaning.

**Do the Numbers Make Sense?:** This worksheet has several examples concerned with miscalculations and misinterpretations of statistics, and not their graphical displays.